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Harding Lawson Associates

January 9, 1998

39860 354

Mr. Wayne Praskins
Project Manager
United States Environmental Protection Agency
75 Hawthorne Street
San Fransisco, California 94105-3901

Progress Report
Phase 1 Perchlorate Treatability Study
Baldwin Park Operable Unit
San Gabriel Basin

Dear Mr. Praskins:

INTRODUCTION

On behalf of the Baldwin Park Operable Unit Steering Committee (BPOUSC), Harding Lawson Associates (HLA) is submitting this Progress Report regarding development and refinement of a biochemical reduction technology for removal of perchlorate and nitrate ions from groundwater. This technology has been previously successfully tested, but with respect to different treatment objectives, specifically higher influent concentrations, and higher effluent goals for perchlorate. Analytical testing methods used in the previous treatability studies were capable of reporting concentrations of perchlorate to 400 micrograms per liter (μg/L), while current methods are capable of reporting concentrations to 4 μg/L.

For efficiency, this treatability study has been separated into two phases. The purpose of Phase 1 is to evaluate the application of the previously tested biochemical reduction technology to treatment of groundwater with lower influent concentrations of perchlorate and higher influent concentrations of nitrate, while achieving a lower effluent concentration of perchlorate. The purpose of Phase 2 is to develop the engineering and performance data necessary to design, construct, and operate a full-scale treatment system in the San Gabriel Basin.

The purpose of this Progress Report is to describe progress made on the Phase 1 portion of this perchlorate treatability study through December 15, 1997, and to address plans for performance of the Phase 2 portion of this study. The Phase 1 treatability study is being conducted at Aerojet General Corporation's facility in Rancho Cordova, California. The scope and approach for the Phase 1 treatability study described in this report was provided in HLA's November 7, 1997 document, *Phase 1 Treatability Study Work Plan, Perchlorate in Groundwater, Baldwin Park Operable Unit, San Gabriel Basin* (Work Plan).

CONSTRUCTION AND SYSTEM DESCRIPTION

Construction of the treatment system began on October 17, 1997, and was completed on November 5, 1997. On November 21, 1997, HLA provided a system description and general system arrangement drawing to the United States Environmental Protection Agency (USEPA). This system description and general arrangement drawing have been slightly revised to reflect the addition of a carbon separator system. The revised system description and general arrangement drawing are attached.

Engineering and
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PILOT PLANT OPERATIONS

As of December 15, 1997, the Phase 1 pilot plant had been operating for 5 weeks. At the time the Work Plan was written, the goals of the first 2 weeks of operation were to (1) establish and grow the microbial population necessary to reduce perchlorate and nitrate; (2) establish complete or near complete perchlorate and nitrate removal regardless of nutrient requirements, organic substrate loading rates, operating conditions, and effluent quality; (3) increase the system flow rate to the design flow rate of 30 gallons per minute (gpm); and (4) collect analytical data needed to understand the mechanism and controls on perchlorate and nitrate destruction. The remainder of the 8-week treatability test could then be used to run the system under near steady-state conditions, making slight changes to nutrient loading and operating conditions to optimize the efficiency of perchlorate and nitrate destruction, while reducing concentrations of the organic substrate and nutrients in the pilot plant effluent to acceptable levels.

Initially, it was thought that complete perchlorate and nitrate removal could be established at the maximum 30 gpm flow rate within 1 to 2 weeks. However, it took longer than expected to establish a healthy microbial population. Some unforeseen delays, mechanical equipment problems, and the desire to proceed cautiously have resulted in the lengthened schedule. Details are described below.

The operational approach was to first establish a healthy microbial population by running the pilot plant in recycle mode. The pilot plant is designed to constantly run at a flow rate of 30 gpm through the bioreactor. System design allows the operators to vary the proportion of well water and recycle water. With no input from the well, the system runs at 30 gpm in recycle mode. Well flow can be increased on a continuum until the pilot plant is running at 30 gpm on well water without significant recycle water.

Once the microbial population was established, the approach was to increase the influent groundwater flow rate in 5 to 10 gpm increments, allowing the bioreactor to stabilize between increases in flow. Based on past experience with other biological treatment systems, a period of at least 2 days was allowed for stabilization prior to the next increase in the flow rate. As a starting point, the required ethanol flow rate was initially calculated using data derived from the previous perchlorate study. Nutrient loading rates were set according to known microbial requirements. Initially, a nutrient mix of urea and diammonium-phosphate was used; however, after consideration of the high nitrate content of the water, it was decided that there would be no need to add nitrogen as a nutrient and that hexametaphosphate would suffice as the only nutrient. Analytical data along with measured field parameters (which were collected daily) were used to determine bioreactor stabilization. Once perchlorate and nitrate reduction to their relative detection limits was established at an influent well flow rate of 30 gpm, detailed analytical sampling (bioreactor profiling) would begin as described in the Work Plan.

Water samples intended for laboratory analysis were collected from five sample ports, designated A, B, C, G, and BS. Sample ports A and B represent the air stripper influent and effluent, which is undiluted groundwater direct from the well. Sample port C is located immediately before the bioreactor, and sample port G is located immediately following the bioreactor. Samples collected from sample ports C and G represent bioreactor influent and effluent, which consists of undiluted groundwater mixed with recycle water (if any). Sample port BS is located on the air stripper effluent pipe, after the ethanol addition point, near the basket-strainers. Samples collected from BS represent the unmixed system groundwater influent flow with ethanol addition.

Samples were collected and analyzed as outlined in the Work Plan, with the exception of samples collected at port BS. It was decided that phosphorus samples from ports C and G as well as bacteriology samples from port G would be collected 7 days per week rather than once per week. Duplicate samples and trip blanks, as described in the Work Plan, were also collected. A summary of laboratory analytical results is attached as Table 1. Duplicate and trip blank sample results will be provided in the final progress report with other quality control/quality assurance data and data analysis. A summary of the measured field parameters is attached as Table 2.

On November 5, 1997, granular activated carbon and microorganisms were added to the bioreactor. Baseline groundwater samples were also collected and analyzed at that time.

November 7 through 19, 1997

The bioreactor was operated in recycle mode at a flow rate of 30 gpm from November 5 until November 7, when the influent groundwater flow rate was increased to 5 gpm and the recycle flow rate reduced to 25 gpm. At that time, the first set of water quality samples was collected. Samples were not collected on Saturday, November 8, because the unit was shut down to fix an electrical control problem. During this initial startup period, a few mechanical problems with the ethanol metering pump and the air stripper were encountered and solved.

The unit was operated at 5 gpm influent groundwater flow rate until November 19, to ensure that the microorganism population attached to the carbon was sufficiently high and would not wash out of the bioreactor at higher influent flow rates. While the unit was operating at 5 gpm, the concentration of perchlorate entering into the bioreactor was diluted by the recycle water to below its detection limit of 4 parts per billion (ppb); therefore, detection of perchlorate reduction was not possible. Some reduction in nitrate concentrations was observed. To assist microbial growth, batch additions of nitrate were made to the system from November 15 through 19.

November 19 through 25, 1997

On November 19, the influent groundwater flow rate was increased to 10 gpm, with the recycle flow set at 20 gpm. The first samples collected at this flow rate were collected on November 20. At this flow rate, some perchlorate and nitrate reduction was observed. No samples were collected on November 22 and 23 because the treatment system was shut down due to a planned power outage at the Aerojet facility. The unit was operated at this flow rate until November 25.

November 25 through 27, 1997

On November 25, the influent groundwater flow rate was increased to 15 gpm and the recycle flow set at 15 gpm. The first samples collected at this flow rate were collected November 26. Removal of nitrate and perchlorate to their relative detection limits was observed within 24 hours of the change in flow rate. The unit was operated at this flow rate through November 27.

November 28 through December 2, 1997

On November 28, the influent groundwater flow rate was increased to 20 gpm with the recycle flow set at 10 gpm. Complete removal of nitrate and perchlorate to detection limits was observed at this flow rate within 5 days of the change in flow rate. It was noticed that copious amounts of nitrogen gas bubbles were being created as a result of the denitrification (nitrate reduction) occurring in the bioreactor. Some of these nitrogen bubbles attached to granules of carbon/biomass, carrying the carbon/biomass out of the bioreactor, which led to the plugging of system piping.

December 2 through 4, 1997

From December 2 through 4, a carbon separator system was installed in the bioreactor effluent pipe to prevent carbon loss. Carbon is settled out of the water stream in a separator tank and is pumped back into the bioreactor every day. During the installation of this carbon separator the pilot plant was shut down on several occasions, but the durations of these shutdowns were only approximately 2 to 4 hours each. Therefore, it was expected that minimal disruption to the microorganism population occurred. The complete system with the carbon separator was fully operational by December 5.

During the installation of the carbon separator, it was noted that the presence of an unknown white, mucous-like substance had caused carbon granules to clump together in the bioreactor. Such clumping decreases surface area within the bioreactor, thereby potentially decreasing performance. This substance had also been encountered during the previous perchlorate study conducted at Aerojet. The extent to which this substance is present appears to be directly related to the amount of excess ethanol added to the system. In order to decrease the presence of this substance, the ethanol flow rate was decreased and optimized so that nitrate (which is the constituent present in the greatest amount) would be removed to the greatest possible extent without excessive ethanol present.

December 5 through 15, 1997

Following the carbon separator installation, the unit was operating at a groundwater flow rate of 20 gpm with 10 gpm of recycle water. Dissolved oxygen (DO) levels in the effluent were approximately 3 milligrams per liter (mg/L). Under conditions where complete nitrate and perchlorate destruction was observed, the effluent DO was approximately 0.1 mg/L. Because it was assumed that disruptions during installation of the carbon separator had caused loss of micro-organisms, the influent flow rate was decreased to 5 gpm to rebuild the microbial population.

The influent flow rate was then slowly increased and by December 10, the flow rate had been increased to 30 gpm and the recycle flow set to zero. During this increase in flow rate, moderate levels of perchlorate and nitrate reduction were occurring. Although nitrate and perchlorate destruction was not complete, it was assumed that with continued operation the previous effectiveness in perchlorate and nitrate destruction would be reestablished. Complete reduction of nitrate was established within 4 days of the change in flow rate, but this destruction efficiency was not maintained. Approximately 30 percent perchlorate reduction was achieved with slight concentrations of ethanol in the effluent.

DISCUSSION AND SCHEDULE

Phase 1 Treatability Study

With influent groundwater flow rates of 10, 15, and 20 gpm, complete destruction of perchlorate and nitrate to respective detection limits of 4 μg/L and 0.1 mg/L was achieved. At higher flow rates (25 and 30 gpm), near complete nitrate removal but only partial perchlorate (approximately 30 percent) removal was achieved.

In the next few weeks pilot plant operating conditions will be modified to determine if perchlorate reduction performance can be improved at an influent groundwater flow rate of 30 gpm. If complete perchlorate reduction cannot be achieved at 30 gpm, the influent groundwater flow rate will be reduced to a flow rate where complete reduction can be established. Bioreactor analytical profiling would then be performed at that flow rate. It is expected that bioreactor profiling should be completed by the end of January 1998. The length of the remaining performance monitoring period will be redefined after collection and evaluation of the bioreactor profiling analytical results.

Phase 2 Treatability Study

Because complete destruction of perchlorate and nitrate has not yet been achieved using the Phase 1 treatment system, is not prudent to prepare a Phase 2 Treatability Study Work Plan. Once reduction of perchlorate and nitrate concentrations to acceptable levels can be achieved, a Phase 2 Work Plan will be prepared. Until such time, assumptions regarding the scope and approach to Phase 2 may be invalid or require substantial modification.

Although a work plan has not been prepared, planning for the Phase 2 Treatability Study is underway. The BPOUSC has had several meetings with La Puente Valley Water District (LPVWD) and the Main San Gabriel Basin Watermaster (Watermaster) regarding performance of Phase 2 testing at the LPVWD well and treatment plant site. Substantial progress has been made on a number of issues directly related to the design, construction, and operation of the Phase 2 Treatability Study. Technical representatives of LPVWD, the Watermaster, and the BPOUSC have discussed well selection, pumping rate, design and operation of the existing treatment plant, design and layout of the pilot plant, as well as discharge and storage requirements. The Regional Water Quality Control Board (RWQCB) discharge permit, held by the Watermaster, and modifications to this permit made by LPVWD were discussed and a plan to obtain RWQCB input developed. Representatives of the California Department of Health Services were present at the most recent meeting where requirements for pilot plant operations, monitoring, and discharge of treated water to the public were discussed.

Counsel to the BPOUSC, Three Valleys Municipal Water District (TVMWD), and LPVWD are preparing an agreement for performing Phase 2 testing. Issues being resolved include site access, ownership of the treatment equipment, and language that will be needed in the agreement to satisfy TVMWD, LPVWD, and BPOUSC legal requirements.

Assuming that complete or near complete reduction of perchlorate and nitrate can be reestablished and consistent performance be realized within the month of January 1998, it is expected that there will be sufficient confidence in this treatment technique to prepare a Phase 2 Treatability Study Work Plan by the end of February 1998.

CLOSURE

The BPOUSC and HLA assume that this report provides all of the information the USEPA requires at this time. If you have any questions or require additional information, please contact Don Vanderkar of Aerojet at (916) 355-4282 or John Catts of HLA at (415) 899-8825.

Yours very truly,

HARDING LAWSON ASSOCIATES

Kevin J. Trout
Project Engineer

For:
John G. Catts, Ph.D
Vice President
Chief Technical Officer

KJT/JC/kjt\sg
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Attachments: Table 1 - Laboratory Analytical Results Summary
Table 2 - Field Parameter Summary
Attachment 1 - Treatment System Description
Attachment 2 - General Arrangement Drawing

Table 1. Laboratory
Analytical Results Summary

	DATE SAMPLED	11/5/97	11/7/97	11/9/97	11/10/97	11/11/97	11/12/97	11/13/97	11/14/97	11/15/97	11/16/97	11/16/97 Even.
	INFLUENT GW FLOWRATE (GPM)	-	5.1	3.8	3.6	3.5	4.1	3.8	4.0	3.8	3.9	-
SAMPLING PORT	ANALYTES											
Air Strip. Infl. (A)	VOCs - 1,1-Dichloroethene (ug/l)	6.3	6.3	-	-	-	-	-	-	-	-	-
Air Strip. Eff. (B)	VOCs - 1,1-Dichloroethene (ug/l)	-	<5	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	VOCs - 1,1-Dichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	VOCs - 1,1-Dichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	VOCs - Trichloroethene (ug/l)	120	110	-	-	-	-	-	-	-	-	-
Air Strip. Eff. (B)	VOCs - Trichloroethene (ug/l)	-	<5	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	VOCs - Trichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	VOCs - Trichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Alcohols, Ethanol (mg/l)	<10	-	-	-	-	-	-	-	-	-	-
Undiluted GW (BS)	Alcohols, Ethanol (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Alcohols, Ethanol (mg/l)	-	94	32	17	21	30	33	<10	<10	<10	-
Reactor Effluent (G)	Alcohols, Ethanol (mg/l)	-	61	24	20	24	22	23	<10	<10	<10	-
Air Strip. Infl. (A)	Perchlorate (ug/l)	38	-	-	-	-	-	-	-	-	-	-
Undiluted GW (BS)	Perchlorate (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Perchlorate (ug/l)	-	<4	<4	<4	<4	<4	<4	<4	<4	<4	-
Reactor Effluent (G)	Perchlorate (ug/l)	-	<4	<4	<4	<4	<4	<4	<4	<4	<4	-
Air Strip. Infl. (A)	Chlorate (mg/l)	<2	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Chlorite (mg/l)	<.2	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Chlorate, Chlorite (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Chlorate, Chlorite (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Alkalinity as CaCO3 (mg/l)	100	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Alkalinity as CaCO3 (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Alkalinity as CaCO3 (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Chloride (mg/l)	8.5	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Chloride (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Chloride (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Total Phosphorus (mg/l)	0.1	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Total Phosphorus (mg/l)	-	1.60	1.10	1.30	1.30	0.91	14.00	2.30	2.40	8.40	-
Reactor Effluent (G)	Total Phosphorus (mg/l)	-	1.60	1.20	1.30	1.20	0.88	13.00	2.30	2.70	6.70	-
Air Strip. Infl. (A)	Ammonia Nitrogen (mg/l)	<0.1	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Ammonia Nitrogen (mg/l)	-	2.70	0.15	0.48	0.26	0.41	0.46	9.60	4.10	15.00	-
Reactor Effluent (G)	Ammonia Nitrogen (mg/l)	-	2.80	<0.1	0.17	0.29	0.19	0.21	8.90	3.60	2.20	-
Air Strip. Infl. (A)	Nitrate Nitrogen (mg/l)	13.0	-	-	-	-	-	15	-	-	-	-
Air Strip. Eff. (B)	Nitrate Nitrogen (mg/l)	-	-	-	-	-	-	12	-	-	-	-
Undiluted GW (BS)	Nitrate Nitrogen (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Nitrate Nitrogen (mg/l)	-	10	3.3	<0.1	<0.1	<0.1	0.63	11	8.4	<0.1	2.1
Reactor Effluent (G)	Nitrate Nitrogen (mg/l)	-	11	2.2	<0.1	<0.1	<0.1	<0.1	10	7.5	0.46	0.48
Air Strip. Infl. (A)	Nitrite Nitrogen (mg/l)	<0.03	-	-	-	-	-	<0.03	-	-	-	-
Air Strip. Eff. (B)	Nitrite Nitrogen (mg/l)	-	-	-	-	-	-	<0.03	-	-	-	-
Undiluted GW (BS)	Nitrite Nitrogen (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Nitrite Nitrogen (mg/l)	-	0.19	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Reactor Effluent (G)	Nitrite Nitrogen (mg/l)	-	0.21	0.13	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Air Strip. Infl. (A)	Sulfate (mg/l)	13	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Sulfide (mg/l)	<1	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Sulfate, Sulfide (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Sulfate, Sulfide (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Title 22 Metals (ug/l)- Ba,V,Zn,Ca	23 / 14 / 35 / 18,000	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Title 22 Metals (ug/l)-Mg,Na,K	11,000 / 30,000 / 1,200	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Title 22 Metals (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Title 22 Metals (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Fecal Coliform (MPN/100ml)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Fecal Coliform (MPN/100ml)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Fecal Coliform (MPN/100ml)	-	-	-	-	-	0	absent	0	-	0	-
Air Strip. Infl. (A)	Coliform (MPN/100ml)	absent	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Coliform (MPN/100ml)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Coliform (MPN/100ml)	-	-	-	-	-	2	present	1	-		-
Air Strip. Infl. (A)	Bacteria (CFU/ml)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Bacteria (CFU/ml)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Bacteria (CFU/ml)	-	-	-	-	-	1027	2783	3630	-	8730	-
Air Strip. Infl. (A)	Total Dissolved Solids (mg/l)	300	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Total Dissolved Solids (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Total Dissolved Solids (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Total Suspended Solids (mg/l)	0	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Total Suspended Solids (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Total Suspended Solids (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Turbidity (NTU)	<1.0	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Turbidity (NTU)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Turbidity (NTU)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Biochemical Oxygen Demand (mg/l)	0	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Biochemical Oxygen Demand (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Biochemical Oxygen Demand (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Chemical Oxygen Demand (mg/l)	0	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Chemical Oxygen Demand (mg/l)	-	210	81	120	81	88	86	11	<10	29	-
Reactor Effluent (G)	Chemical Oxygen Demand (mg/l)	-	210	70	72	72	79	97	11	<10	11	-

ug/l = microgram per liter, mg/l = milligram per liter
GW = groundwater, VOC = volatile organic compound
Ba = Barium, V = Vanadium, Zn = Zinc, Mg = Magnesium
Na = Sodium, K = Potassium
MPN/ml = most probable number per milliliter
CFU/ml = colony forming units per milliliter
NTU = nephelometric turbidity units

	DATE SAMPLED	11/17/97	11/17/97 Even.	11/18/97	11/18/97 Even.	11/19/97	11/19/97 Even.	11/20/97	11/21/97	11/24/97	11/25/97	11/26/97	11/28/97
	INFLUENT GW FLOWRATE (GPM)	4.0	-	4.3	-	4.4	-	10.1	9.8	10.9	10.6	15.2	20.1
SAMPLING PORT	ANALYTES												
Air Strip. Infl. (A)	VOCs - 1,1-Dichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Eff. (B)	VOCs - 1,1-Dichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	VOCs - 1,1-Dichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	VOCs - 1,1-Dichloroethene (ug/l)	<5	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	VOCs - Trichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Eff. (B)	VOCs - Trichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	VOCs - Trichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	VOCs - Trichloroethene (ug/l)	<5	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Alcohols, Ethanol (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Undiluted GW (BS)	Alcohols, Ethanol (mg/l)	-	-	30	-	180	-	200	94	46	51	120	<10
Reactor Influent (C)	Alcohols, Ethanol (mg/l)	<10	-	33	-	-	-	130	23	34	59	110	<10
Reactor Effluent (G)	Alcohols, Ethanol (mg/l)	<10	-	21	-	-	-	180	<10	<10	<10	68	<10
Air Strip. Infl. (A)	Perchlorate (ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
Undiluted GW (BS)	Perchlorate (ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Perchlorate (ug/l)	<4	-	<4	-	<4	-	<4	7.6	8.1	11	9	<4
Reactor Effluent (G)	Perchlorate (ug/l)	<4	-	<4	-	<4	-	<4	<4	<4	6.2	<4	<4
Air Strip. Infl. (A)	Chlorate (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Chlorite (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Chlorate, Chlorite (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Chlorate, Chlorite (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Alkalinity as CaCO3 (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Alkalinity as CaCO3 (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Alkalinity as CaCO3 (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Chloride (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Chloride (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Chloride (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Total Phosphorus (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Total Phosphorus (mg/l)	3.60	-	0.94	-	3.1	-	1.3	0.33	0.41	0.46	0.48	0.46
Reactor Effluent (G)	Total Phosphorus (mg/l)	3.50	-	1.1	-	3.7	-	1.3	0.27	0.37	0.38	0.36	0.77
Air Strip. Infl. (A)	Ammonia Nitrogen (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Ammonia Nitrogen (mg/l)	2.50	-	<0.1	-	0.63	-	0.26	0.19	<0.1	<0.1	0.10	0.77
Reactor Effluent (G)	Ammonia Nitrogen (mg/l)	3.70	-	<0.1	-	0.47	-	0.12	0.10	<0.1	<0.1	<0.1	1.00
Air Strip. Infl. (A)	Nitrate Nitrogen (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Eff. (B)	Nitrate Nitrogen (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Undiluted GW (BS)	Nitrate Nitrogen (mg/l)	-	-	-	-	-	-	9.2	12	11	12	12	12
Reactor Influent (C)	Nitrate Nitrogen (mg/l)	4.3	2.0	0.22	<0.1	1.3	0.97	0.75	4.5	8.9	9.4	5.30	8.90
Reactor Effluent (G)	Nitrate Nitrogen (mg/l)	3.3	2.6	<0.1	<0.1	<0.1	<0.1	<0.1	2.8	7.8	7.9	<0.1	6.70
Air Strip. Infl. (A)	Nitrite Nitrogen (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Eff. (B)	Nitrite Nitrogen (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Undiluted GW (BS)	Nitrite Nitrogen (mg/l)	-	-	-	-	-	-	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Reactor Influent (C)	Nitrite Nitrogen (mg/l)	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.13	0.10	0.25	0.07	0.33
Reactor Effluent (G)	Nitrite Nitrogen (mg/l)	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.08	0.34	<0.03	0.58
Air Strip. Infl. (A)	Sulfate (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Sulfide (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Sulfate, Sulfide (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Sulfate, Sulfide (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Title 22 Metals (ug/l)- Ba,V,Zn,Ca	-	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Title 22 Metals (ug/l)-Mg,Na,K	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Title 22 Metals (ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Title 22 Metals (ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Fecal Coliform (MPN/100ml)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Fecal Coliform (MPN/100ml)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Fecal Coliform (MPN/100ml)	0	-	0	-	absent	-	0	-	0	0	0	
Air Strip. Infl. (A)	Coliform (MPN/100ml)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Coliform (MPN/100ml)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Coliform (MPN/100ml)		-	3.1	-	present	-	8.7	-	2	9.9	2	-
Air Strip. Infl. (A)	Bacteria (CFU/ml)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Bacteria (CFU/ml)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Bacteria (CFU/ml)	9970	-	2739	-	7300	-	5382	-	2373	1816	1375	-
Air Strip. Infl. (A)	Total Dissolved Solids (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Total Dissolved Solids (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Total Dissolved Solids (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Total Suspended Solids (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Total Suspended Solids (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Total Suspended Solids (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Turbidity (NTU)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Turbidity (NTU)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Turbidity (NTU)	-	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Biochemical Oxygen Demand (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Biochemical Oxygen Demand (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Biochemical Oxygen Demand (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Chemical Oxygen Demand (mg/l)	-	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Chemical Oxygen Demand (mg/l)	<10	-	<10	-	140	-	200	53	55	53	160	11
Reactor Effluent (G)	Chemical Oxygen Demand (mg/l)	<10	-	<10	-	140	-	190	51	<10	<10	130	14

ug/l = microgram per liter, mg/l = milligram per liter
GW = groundwater, VOC = volatile organic compound
Ba = Barium, V = Vanadium, Zn = Zinc, Mg = Magnesium
Na = Sodium, K = Potassium
MPN/ml = most probable number per milliliter
CFU/ml = colony forming units per milliliter
NTU = nephelometric turbidity units

Table 1. Laboratory
Analytical Results Summary

SAMPLING PORT	DATE SAMPLED	11/30/97	12/1/97	12/2/97	12/5/97	12/6/97	12/9/97	12/11/97	12/12/97	12/13/97	12/14/97	12/15/97
	INFLUENT GW FLOWRATE (GPM)	20.2	20.7	19.6	20.5	20.0	5.0	29.9	29.9	29.4	29.6	29.0
SAMPLING PORT	ANALYTES											
Air Strip. Infl. (A)	VOCs - 1,1-Dichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Eff. (B)	VOCs - 1,1-Dichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	VOCs - 1,1-Dichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	VOCs - 1,1-Dichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	VOCs - Trichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Eff. (B)	VOCs - Trichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	VOCs - Trichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	VOCs - Trichloroethene (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Alcohols, Ethanol (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Undiluted GW (BS)	Alcohols, Ethanol (mg/l)	440	220	140	130	110	190	-	-	-	-	-
Reactor Influent (C)	Alcohols, Ethanol (mg/l)	460	120	140	110	110	200	87	84	48	50	78
Reactor Effluent (G)	Alcohols, Ethanol (mg/l)	370	120	100	100	78	190	37	50	<10	<10	12
Air Strip. Infl. (A)	Perchlorate (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Undiluted GW (BS)	Perchlorate (ug/l)	-	-	-	50	49	-	-	-	-	-	-
Reactor Influent (C)	Perchlorate (ug/l)	<4	9.9	14	55	44	-	41	39	40	40	36
Reactor Effluent (G)	Perchlorate (ug/l)	<4	<4	<4	36.0	<20	-	27	34	40	29	24
Air Strip. Infl. (A)	Chlorate (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Chlorite (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Chlorate, Chlorite (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Chlorate, Chlorite (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Alkalinity as CaCO3 (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Alkalinity as CaCO3 (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Alkalinity as CaCO3 (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Chloride (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Chloride (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Chloride (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Total Phosphorus (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Total Phosphorus (mg/l)	0.65	0.14	0.20	0.17	0.54	-	<0.05	0.46	0.28	0.27	0.26
Reactor Effluent (G)	Total Phosphorus (mg/l)	0.48	0.10	0.10	0.10	0.69	-	<0.05	0.37	0.15	0.17	0.15
Air Strip. Infl. (A)	Ammonia Nitrogen (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Ammonia Nitrogen (mg/l)	0.13	0.11	0.32	0.31	0.28	-	0.14	<0.1	<0.1	<0.1	<0.1
Reactor Effluent (G)	Ammonia Nitrogen (mg/l)	0.15	<0.1	0.21	0.5	0.28	-	0.82	0.11	<0.1	<0.1	<0.1
Air Strip. Infl. (A)	Nitrate Nitrogen (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Eff. (B)	Nitrate Nitrogen (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Undiluted GW (BS)	Nitrate Nitrogen (mg/l)	15	11	11	11	10	-	-	-	-	-	-
Reactor Influent (C)	Nitrate Nitrogen (mg/l)	<0.1	5.9	6.6	8.2	9.8	-	11	14	0.21	13	13
Reactor Effluent (G)	Nitrate Nitrogen (mg/l)	<0.1	<0.1	<0.1	7.1	5.7	-	7.9	9.5	2	<0.1	0.64
Air Strip. Infl. (A)	Nitrite Nitrogen (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Eff. (B)	Nitrite Nitrogen (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Undiluted GW (BS)	Nitrite Nitrogen (mg/l)	<0.03	<0.03	<0.03	<0.03	<0.03	-	-	-	-	-	-
Reactor Influent (C)	Nitrite Nitrogen (mg/l)	<0.03	<0.03	0.08	0.15	<0.03	-	0.04	<0.03	0.051	<0.03	<0.03
Reactor Effluent (G)	Nitrite Nitrogen (mg/l)	<0.03	<0.03	<0.03	0.5	<0.03	-	0.53	0.33	1.6	0.034	0.18
Air Strip. Infl. (A)	Sulfate (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Sulfide (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Sulfate, Sulfide (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Sulfate, Sulfide (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Title 22 Metals (ug/l)- Ba,V,Zn,Ca	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Title 22 Metals (ug/l)-Mg,Na,K	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Title 22 Metals (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Title 22 Metals (ug/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Fecal Coliform (MPN/100ml)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Fecal Coliform (MPN/100ml)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Fecal Coliform (MPN/100ml)	1	0	0	0	-	-	0	0	-	0	1
Air Strip. Infl. (A)	Coliform (MPN/100ml)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Coliform (MPN/100ml)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Coliform (MPN/100ml)	>200.5	1	2	2	-	-	1	1	-	0	1
Air Strip. Infl. (A)	Bacteria (CFU/ml)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Bacteria (CFU/ml)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Bacteria (CFU/ml)	5381	2372	2164	1306	-	-	760	320	-	1237	1118
Air Strip. Infl. (A)	Total Dissolved Solids (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Total Dissolved Solids (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Total Dissolved Solids (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Total Suspended Solids (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Total Suspended Solids (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Total Suspended Solids (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Turbidity (NTU)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Turbidity (NTU)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Turbidity (NTU)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Biochemical Oxygen Demand (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Biochemical Oxygen Demand (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Effluent (G)	Biochemical Oxygen Demand (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Air Strip. Infl. (A)	Chemical Oxygen Demand (mg/l)	-	-	-	-	-	-	-	-	-	-	-
Reactor Influent (C)	Chemical Oxygen Demand (mg/l)	600	270	410	130	110	-	100	120	110	91	100
Reactor Effluent (G)	Chemical Oxygen Demand (mg/l)	590	260	410	110	87	-	98	98	69	52	52

ug/l = microgram per liter, mg/l = milligram per liter
GW = groundwater, VOC = volatile organic compound
Ba = Barium, V = Vanadium, Zn = Zinc, Mg = Magnesium
Na = Sodium, K = Potassium
MPN/ml = most probable number per milliliter
CFU/ml = colony forming units per milliliter
NTU = nephelometric turbidity units

Date	Flowrate		pH		Temp.		ORP		DO	
	Influent GW	Total Reactor	Infl.	Effl.	Infl.	Effl.	Infl.	Effl.	Infl.	Effl.
	gpm	gpm			deg. C	deg. C	mV	mV	ppm	ppm
11/7/97	5.1	30.1	8.38	7.15	22.1	22.1	0.0	-0.1	1.4	0.1
11/8/97	3.9	30.1	8.22	8.34	18.3	18.6	-0.8	-0.1	1.6	0.1
11/9/97	3.8	29.7	8.43	8.39	19.6	19.9	-0.9	-0.8	1.1	0.1
11/10/97	3.6	29.5	8.34	7.93	18.6	19.1	-0.2	-0.1	1.0	0.0
11/11/97	3.5	30.1	8.76	8.70	18.0	18.7	-0.2	-0.1	0.7	0.1
11/12/97	4.1	30.6	8.55	8.62	20.2	19.6	-0.3	-0.2	0.6	0.0
11/13/97	3.8	30.0	8.50	7.17	19.1	18.8	0.1	0.3	1.2	0.0
11/14/97	4.0	30.0	8.92	8.90	19.3	19.3	-0.1	0.1	1.5	0.6
11/15/97	3.8	29.9	NR	8.00	15.0	15.9	0.1	0.0	1.2	0.1
11/16/97	3.9	30.1	NR	7.48	17.1	17.2	-0.6	-0.6	1.3	0.1
11/17/97	4.0	29.9	8.67	8.81	19.1	19.2	-0.3	-0.3	0.9	1.0
11/18/97	4.3	27.0	8.35	8.41	18.2	18.4	-0.1	-0.2	0.7	0.0
11/19/97	4.4	29.6	8.36	8.36	18.6	18.5	-0.8	-0.7	1.1	0.0
11/20/97	10.1	29.5	NM	8.07	18.7	18.6	-0.6	-0.6	0.7	0.0
11/21/97	9.8	30.7	NM	8.21	18.9	19.2	-0.6	-0.8	0.5	0.0
11/24/97	10.9	30.8	8.21	8.27	19.9	20.1	0.2	0.2	0.4	0.1
11/25/97	10.6	30.5	7.99	8.07	19.5	19.3	0.1	0.3	0.4	0.2
11/26/97	15.2	30.2	8.45	8.61	14.5	15.4	NM	NM	0.4	0.1
11/27/97	15.0	30.0	NM	NM	NM	NM	NM	NM	NM	NM
11/28/97	20.1	31.1	8.34	8.46	17.7	17.4	NM	NM	0.4	0.1
11/29/97	20.0	30.0	NM	NM	NM	NM	NM	NM	NM	NM
11/30/97	20.2	31.3	8.46	8.61	13.9	14.3	NM	NM	5.3	0.5
12/1/97	20.7	30.8	8.38	8.53	13.9	14.7	NM	NM	4.6	0.1
12/2/97	19.6	25.0	8.10	8.29	15.2	15.7	NM	NM	4.1	0.0
12/5/97	20.5	29.9	8.20	8.09	15.3	14.4	NM	NM	6.0	3.3
12/6/97	20.0	30.2	8.30	8.05	16.6	16.6	NM	NM	6.1	2.7
12/7/97	5.0	29.3	NM	NM	NM	NM	NM	NM	NM	NM
12/8/97	10.3	29.8	7.83	7.72	13.3	14.7	NM	NM	5.2	2.5
12/9/97	10.0	31.0	8.00	8.08	18.3	18.1	110.0	96.3	4.3	1.5
12/10/97	10.0	30.3	7.29	7.00	17.5	18.0	-41.1	-72.1	NM	1.5
12/11/97	29.9	30.8	7.96	7.64	18.3	18.6	118.5	35.0	8.3	0.3
12/12/97	29.9	31.0	7.67	7.87	17.5	16.3	153.3	180.5	8.1	2.0
12/13/97	29.4	30.4	7.49	7.56	17.8	16.7	228.6	172.7	NM	0.5
12/14/97	29.6	30.4	7.60	8.17	18.3	17.3	108.6	71.4	8.2	0.2
12/15/97	29.0	30.2	8.22	8.58	18.5	18.5	104.6	96.0	8.4	0.2

Notes:

GW = groundwater, GPM = gallons per minute, ORP = oxidation-reduction potential, DO = dissolved oxygen
MV = milli-volts, PPM = parts per million, NM = not measured
Replaced ORP probe 12/9/97

[redacted]

[redacted]